

chamber to 60 Torr and setting the irradiation quantity to about $4 \mu\text{C}/\text{cm}^2 \cdot \text{sec}$ for about 30 seconds until the end of the subsequent electron beam irradiation. The energy of the electron beam is set in a range of 1 - 15 keV. The total quantity of electrons incident to the substrate (total irradiation quantity) is 500 $\mu\text{C}/\text{cm}^2$. The total irradiation quantity is not limited to the above value, i.e. the total irradiation quantity is set that polymethyl siloxane film is not modified.

Now, an electron beam irradiation apparatus used in the present embodiment and the following embodiments will be described with reference to FIGS. 2A and 2B.

At least one electron beam generating section 22 is provided at the upper part of a reactor chamber 21 where the electron beam irradiation is carried, the electron beam generating section 22 is isolated from the reactor chamber 21 by a bulkhead 23; and the electron beam 24 is introduced in the reactor chamber 21 through the bulkhead 23. At the lower part of the reactor chamber 21, a hot plate 25 is provided at a position opposite to the lower part of the electron beam generating section 22. FIG. 2A shows an apparatus when one electron beam generating section 22 is provided, and FIG. 2B shows an apparatus when a plurality of electron beam generating sections 22 are provided.

A semiconductor substrate 1 having the coat film formed thereon is placed on the hot plate 25, and the semiconductor substrate 1 is irradiated with the electron beam 24 under a desired condition. Here, the hot plate 25 is connected to a control unit (not shown), and the hot plate 25 is maintained at a desired temperature by the control unit. By using the hot plate 25, the semiconductor substrate 1 placed thereon is held at a nearly uniform temperature, and the uniformity of processing is ensured.

On the other hand, a commercially available electronic irradiation apparatus includes an ElectronCure (TM) device available from Electron vision inc., the United States. A plasma is used for an electron beam source of the above apparatus. The electrons in the plasma is drawn to a substrate reactor chamber via a mesh and the electron beam generating section and reactor chamber are always in the same atmosphere.

Therefore, if a gas containing an organic component is generated from a film to be treated by means of the electron beam irradiation treatment, the pressure in an electric discharge region rapidly changes. If the pressure in the electric discharge region rapidly changes, the electron beam source becomes unstable. As a result, uniform irradiation of electron beams becomes impossible. Therefore, when the above apparatus is used, there occurs a problem that a

dispersion occurs with characteristics of film after burned, permittivity or mechanical strength, for example.

In contrast, in the electron beam irradiation apparatus used in the present embodiment, a bulkhead 23 is provided between the electron beam generating section 22 and the object to be irradiated (semiconductor substrate 1 having a coat film formed thereon) so that the object is irradiated with the electron beam 24 via the bulkhead 23. Therefore, an effect of gas generated from the object on the electron beam generating section 22 is restrained by the bulkhead 23. As a result, the object can be irradiated with uniform electron beam 24, and the dispersion can be eliminated from characteristics of the film after burned.

The interlayer insulation film formed by the above method is formed by bridge due to dehydrate condensation of the precursor included in the raw material. Film contraction occurs during such bridge, and the residual stress occurs with the film after film forming due to such film contraction.

In the case where a coat film is cured by only heat treatment such as in a conventional manner, the contraction of the coat film occurs while the semiconductor substrate is thermally expanded. Therefore, when the coat film is cooled to room